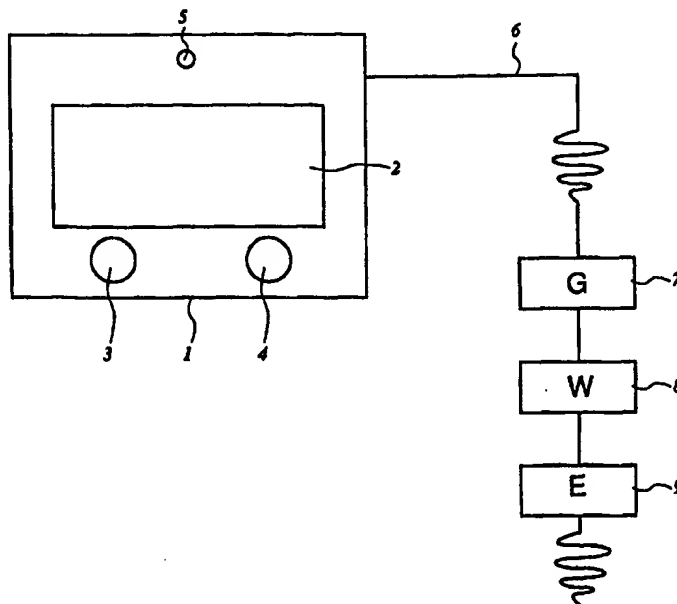




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(21) International Application Number: PCT/NL98/00391 (22) International Filing Date: 8 July 1998 (08.07.98) (30) Priority Data: 1006568 11 July 1997 (11.07.97) NL (71) Applicant (for all designated States except US): NEDERLANDSE ORGANISATIE VOOR TOEGEPASTNATUURWETENSCHAPPELIJK ONDERZOEK TNO [NL/NL]; Schoemakerstraat 97, NL-2628 VK Delft (NL). (72) Inventor; and (75) Inventor/Applicant (for US only): HABETS, Roger, Joseph, Lucia [NL/NL]; Rodinstraat 22, NL-5623 EL Eindhoven (NL). (74) Agent: BAKKUM, R., J.; Van Exter Polak & Charlouis B.V., P.O. Box 3241, NL-2280 GE Rijswijk (NL).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report. In English translation (filed in Dutch).</i>	

(54) Title: DEVICE FOR MONITORING ONE OR MORE CONSUMPTION METERS



(57) Abstract

Device for monitoring one or more meters for supplied energy or another product or service, at least comprising one or more sensor assemblies (7, 8, 9) for monitoring the meters, a display unit (2) for displaying data and a data-processing unit which is designed to display the information signals which are obtained using the sensor assemblies (7, 8, 9), by means of the display unit (2), as the actual consumption within a certain period of time and, at the same time, to display the consumption in a corresponding period from the past, as well as a sensor assembly suitable therefor.

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DEVICE FOR MONITORING ONE OR MORE CONSUMPTION METERS

The present invention relates firstly to a device for monitoring one or more meters for supplied energy or another product or service, at least comprising:

- one or more sensor assemblies for monitoring the
5 meters;
- a display unit for displaying data; and
- a data-processing unit.

Devices of this kind are generally known in the prior art. In this connection, reference is made, for
10 example, to EP-A-0,380,046 and EP-A-0,717,286. In both of these European Patent Applications, a light beam is used to illuminate a rotating component of a meter, the reflected light being collected and its intensity analysed. The processed data are in both cases shown to the user in sums
15 using the display unit.

In practice, it has been found that such a manner of providing information relating to the energy consumption or the consumption of a specific product or service to a user does not provide any significant contribution to
20 making any saving.

The object of the present invention is to improve a device of the abovementioned type in such a manner that a user can recognise in a very simple and unambiguous manner whether or not energy, a product or a service is being used
25 economically and cost-effectively. To this end, the device according to the invention is characterized in that the data-processing unit is designed to display the information which is obtained using the sensor assemblies, by means of the display unit, as the actual consumption within a
30 certain period of time and, at the same time, to display a target consumption in a corresponding period.

It has been found that, by presenting the information from the meters monitored with the sensor assemblies to the user according to the invention, the

user, surprisingly, makes considerably more economical use of the energy, the product or the service. Studies have shown that if a user has at his disposal the information as displayed using the device according to the invention, he
5 will automatically consume approximately 7.5% less.

The target consumption can be determined in all sorts of ways. For example, it is possible to take an average of consumption from the past, or a target consumption can be calculated from the consumption from the
10 past corrected by parameters which affect consumption; parameters of this nature are weather conditions, composition of user group (households, institution, industry, etc.), annually rising energy consumption, changes to buildings, etc.

15 In the present application, meters are intended to mean all meters which are used in practice in households, industry, etc. for measuring the consumption of energy, a product or a service. Energy, product or service is intended to mean, for example, gas, electricity, water (hot
20 or cold), steam, oil, central heating, network services, cable services, telephone services, etc.

The device according to the invention is in principle suitable for any meter and, whether this meter uses rotating wheels with one or more markings, rotating
25 numbered wheels or, for example, a digital display is not important.

Using the device according to the invention, it is possible to utilize the information obtained from the meters very advantageously. By way of example, this
30 information can be returned to the suppliers of the energy, the product or the service, so that they can use the consumption information from the users in order, for example, to be able to carry out so-called "peak shaving". In other words, it is possible to establish which user
35 consumes the most energy or product, or makes the most intensive use of a certain service, at which time. Thus it is possible to take such peak loads into account in advance. It is even possible to give feedback to the user, so that it becomes possible, during peak loads of, for

example, electricity consumption by a user, to switch off certain equipment. Consideration may be given in this connection to, for example, temporarily switching off freezers or the like during these peak load periods.

5 Advantageously, the device furthermore comprises input means with which the type of energy, product or service to be displayed, as well as the period of time, can be selected. In the present application, a period of time is intended to mean, for example, a day, week, month or
10 year, although obviously other periods could equally be used.

 Input means are intended, for example, to mean push buttons with which the user can change the display on the display unit. By way of example, it is possible to select
15 gas, water or electricity for a period of one day, week, month or year.

 Advantageously, the display unit is designed in such a way that it comprises a display screen, with the current consumption displayed in the centre while
20 consumption in the past within the set period of time is displayed to the left of this and the target consumption in a corresponding period is displayed to the left and right of this. This will also be explained further in more detail with reference to the description of the figures.

25 Preferably, the device furthermore comprises signalling means with which the quality of the consumption of the energy, product or service in question can be indicated. Particularly preferably, the signalling means comprise a red and a green lamp.

30 Since, by way of example, excessive consumption at a specific instant compared with a corresponding period from the past does not always have to indicate consumption which is too high in qualitative terms, it has proven advantageous to add a signalling means to the device
35 indicating the quality. In the case mentioned above, the red lamp means excessive consumption and the green lamp means economical consumption compared with the past. For privacy reasons, it may also be desirable, instead of a display on the display unit, to use only the signalling

means.

Advantageously, the device may also be coupled to an external temperature meter, so that consumption can be corrected for the outside temperature. In other words, if
5 the outside temperature falls significantly, economical energy consumption can still be obtained and a green lamp can continue to be lit, while the consumption compared with the target consumption in a corresponding period might appear to be excessive. Similarly, it is possible to
10 correct for other weather effects, such as wind, etc.

In particular, the display unit comprises a liquid crystal screen (LCD) of the dedicated display type. A dedicated display type is a screen on which, as it were, symbols to be displayed are preprinted and can be made
15 visible by electrical excitation; the screen is therefore specifically suitable for a certain application. A display screen of this kind is relatively simple and therefore inexpensive to manufacture. An example of a display screen of this kind will be explained below in the description of
20 the figures.

In a particular embodiment of the device according to the invention, the data-processing unit is designed to carry out the following operations with the signals obtained from the one or more sensor assemblies:

- 25 - monitoring of the information signal and comparison of information already received with new information in order to pick out a recurring sequence in the information signal, which sequence corresponds to a consumption quantity.

If, by way of example, a small wheel or disc of a
30 meter rotates, a sensor will emit an information signal which has a certain periodicity, since the same pattern moves past the sensor for every rotation of a disc or wheel through 360°. It will be clear that, depending on the rotational speed of the wheel or other component of the
35 meter, a more extended or compressed information signal will be obtained. However, the data-processing unit is able to compare signals of this nature with one another.

The data-processing unit will monitor the signal until a repetition of the information, i.e. a recurring

sequence, occurs. It is preferable then to select the new recurring sequence as the starting pattern so as to search for a following repetition. Thus gradually occurring changes in the meter will be perceived by the device. In other words, a part of the information signal, of the size of one period, is, as it were, used as a mask for picking out the recurrence. As soon as a recurrence of the sequence occurs, the new sequence is used as a mask for the next operation of picking out a sequence.

10 In a particular embodiment, the data-processing unit is designed to make the information signal received independent of time prior to picking out a recurring sequence. A data-processing unit with a lower processing capacity will then be suitable for processing the same data. If a meter is at a standstill and there is no change in the information signal during a long period of time, it is, of course, unnecessary for the data-processing unit to store the information signals picked up. Preferably, the data-processing unit according to the invention monitors the signal received and stores exclusively minimums and maximums, the difference between which exceeds a certain noise margin, and uses these values for picking out a recurring sequence. This will be explained in more detail below in the description of the figures.

25 The noise margin may be selected in a variety of ways. Preferably, it amounts to approximately one eighth of the difference between the absolute maximum and the absolute minimum which occur in the information signal. It will be clear that this value can be adapted during use if the information signal were to change.

30 With this embodiment, it is possible to detect any form of undesirable or unauthorized use, or any change to the device. The device according to the invention works, in the above embodiment, with specific maximum and minimum values, and is able to detect a substantial change in the information previously obtained, for example as a result of a sensor assembly being removed from a meter. At that moment, it is possible to transmit a signal, for example, to the supplier indicating that the device is being

tampered with.

The device according to the information may comprise memory means which may form a component of the data-processing unit. Memory means may be of any known form and are used for at least temporarily storing data. With the device according to the invention, it is possible, if the specific time-independent information signal processing is employed, to use a very limited memory.

In particular, a data processor is designed to pick out a sequence which recurs in the reverse direction.

By way of example, in horticulture or in the greenhouse sector, it regularly happens that users return energy to the network. In that case, the meter will move in the opposite direction. This too can be detected by the device according to the invention.

Preferably, each sensor assembly comprises its own sensor-signal processing unit. In particular, each sensor-signal processing unit is designed to pick out a recurring sequence in the information signal from the sensor. In this connection, picking out a recurring sequence is also intended to mean a sequence which recurs in the reverse direction.

By carrying out the signal processing of the information signals which are obtained from the sensor assemblies in the relevant sensor assemblies themselves, it is possible to couple all the sensor assemblies to the data-processing unit of the device by means of a bus structure, in other words to loop them through, so that serial communication is possible. This provides the possibility of the data-processing unit of the device being able to activate a particular sensor assembly as selected. Furthermore, it is possible, for example, for a maintenance engineer without difficulties to loop a computer, for example, a laptop, into the system in order to be able to adjust, modify or read out these devices. It is also possible, in a simple manner, to add other units to the device. Consideration may be given here, by way of example, to a looped-through external temperature meter.

In particular, the one or more sensor assemblies

comprise a combination of a light source and a light detector. With the device according to the invention, it is possible to use a very simple sensor assembly. The light source may be a simple LED, while the reflected light is
5 detected by a photomultiplier. Advantageously, the LED is placed on a component with a continuous passage, the passage serving to concentrate the light emitted by the LED. An example of a component of this kind may be a drilled-through block of non-transparent material.

10 Preferably, the light source is pulsed at a suitable frequency. Preferably, this frequency is approximately 1000 Hz. In this way, daylight, neon light and the like are filtered, and also the 50 Hz from the lighting mains and the frequency of standard data-
15 processing units are filtered out. In other words, by pulsing the light source, any interfering environmental influences are filtered out.

Other examples of sensors which can be used in the sensor assemblies according to the present invention,
20 comprise, for example, sensors based on Hall effect measurement, ultrasonic sensors, pressure sensors etc.

In a second aspect, the present invention relates to a sensor assembly, clearly intended for a device according to the invention, at least comprising a sensor
25 which can monitor a meter for supplied energy or another product or service, and a sensor-signal processing unit which is designed to be able to pick out a recurring sequence in the information signal from the sensor. In this context, a recurring sequence is also intended to mean a
30 sequence which recurs in the reverse direction.

Obviously, a sensor of this kind is also suitable for a large number of other applications in which similar problems arise. Consideration may be given here to the monitoring of revolutions of gearwheels, rotational speeds
35 of motors, defects in the moving-belt conveyance of objects, heartbeat measurement etc.

Finally, the invention provides a computer-readable medium, comprising software intended for a data-processing unit for the device according to the invention, and a

computer-readable medium, comprising software for a sensor-signal processing unit for a sensor assembly according to the invention.

Finally, the invention provides a computer-readable
5 medium, comprising software for configuring a computer for general purposes as a data-processing unit intended for the device according to the invention or for a sensor-signalling processing unit for a sensor assembly according to the invention.

10 A very important advantage of the device according to the invention is that it is, as it were, self-learning, since the sensors, for example, do not have to be calibrated, because all that is being monitored are sequences which correspond to, for example, complete
15 revolutions of rotating elements in the meters to be monitored.

The invention will be explained in more detail below with reference to the appended drawing, in which:

- Fig. 1 shows a diagrammatic view of a device according
20 to the invention;
- Fig. 2 shows a diagrammatic depiction of an example of a display screen of a device according to the present invention;
- Fig. 3 shows an example of an information signal with
25 a sequence which recurs in time;
- Fig. 4 shows a practical example of an information signal with a sequence which recurs in time; and
- Fig. 5 shows a time-independent signal, obtained with the aid of the present invention, with a recurring
30 sequence.

Fig. 1 diagrammatically shows a device according to the present invention. It comprises a housing 1 which may be attached, for example, to the wall of a room of a house, often in the region of the central-heating thermostat. The
35 housing 1 comprises a data-processing unit (not shown), a display screen 2, two operating buttons 3 and 4 and a signalling lamp 5. Via a bus system, various sensor assemblies 7, 8 and 9 are connected, via a cable 6 to the data-processing unit. If desired, it is also possible to

loop together more sensor assemblies in this way. It is also possible for an additional unit, such as an external temperature meter or a wind speed meter to be incorporated in the bus system.

5 In the present example, sensor assembly 7 is used to monitor the gas meter, sensor assembly 8 is used to monitor the water meter and sensor assembly 9 is used to monitor the electricity meter. In practice, for example in the case of standard Dutch gas meters, the sensor assembly
10 7 will be placed on the numbered wheel which moves most quickly.

 The sensor assemblies 7, 8, and 9 comprise a sensor in the form of an LED and a photosensitive cell and a sensor-signal processing unit. The sensor-signal processing
15 unit can be used to process even at this stage the information signal obtained using the sensor 7, in order to pick out the recurring sequence, which data can be transmitted to the data-processing unit in the housing 1.

 With the aid of the operating button 3, it is
20 possible to select for display on the display screen 2 between gas consumption, water consumption and electricity consumption, while the button 4 can be used to select between a daily, weekly, monthly and yearly overview. The display will be described in more detail with reference to
25 Fig. 2.

5 denotes a lamp which shows green when consumption is economical and shows red when consumption is excessive.

 The advantage of contactless sensors with, for example, a light source and a light detector is that the
30 meters can be monitored without them having to be adapted in any way.

 Fig. 2 diagrammatically shows an example of a display screen for use in a device 1 according to the invention, the current consumption being indicated in the
35 centre of the screen 2 as indicated at 10. At 14, it is indicated that the display on the screen is a weekly display, and at 15 it is indicated that the consumption shown is the water consumption. As stated earlier, the choice between the different time periods can be controlled

using the button 3 and the choice of the consumption displayed can be controlled using the button 4.

11, 12 and 13 on the left of the screen 2 respectively display the consumption levels of water yesterday, the day before yesterday and the day before that, using solid circles, and the target consumption for corresponding days of a week is displayed using crosses, while on the right, at 16, 17, 18, the target consumption for the coming days of the week is displayed.

10 If a sensor assembly detects a change in a certain meter, for example the rotation of a numbered wheel in a gas meter, a pattern can be obtained, as shown in Fig. 3, when the numbered wheel rotates at a constant speed. Naturally, in practice this will not be the case and it is
15 more likely that a pattern as indicated in Fig. 4 will be obtained. The areas which are slightly horizontal are the periods in which the meter is turning slowly or is even at a standstill. Time is displayed along the X-axis and the amplitude of the information signal detected is displayed
20 along the Y-axis.

If the device according to the present invention is used to monitor the information signal as displayed in Fig. 4, while only the extremes, i.e. maximums and minimums, are stored, the difference between successive maximums and
25 minimums being greater than a certain noise margin, a result as displayed in Fig. 5 will be obtained.

In Fig. 5, an arbitrary unit is plotted along the X-axis and the value of the maximum and minimum amplitudes is displayed along the Y-axis. In this figure, it is easy
30 to recognise a recurring pattern. For the sake of clarity, the maximums and minimums are joined together by lines in Fig. 5. However, the values which are used in the data-processing unit are only the maximums and minimums.

One recurrence of a sequence means one complete
35 revolution of the numbered wheel in question. A diagrammatically depicted mask 19 is used to indicate a sequence (a period) which recurs in the information signal. By moving the mask, as it were, across the signal, each recurrence can be detected. According to the invention,

when a recurrence occurs, in each case the last sequence detected is used as the mask. This means that gradually occurring changes in the meter to be read are perceived by the device and do not have an adverse effect on its
5 operation.

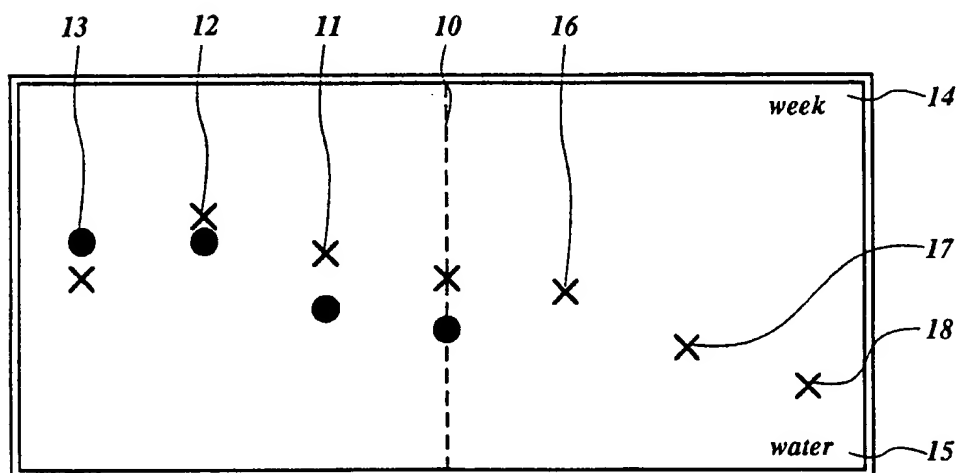
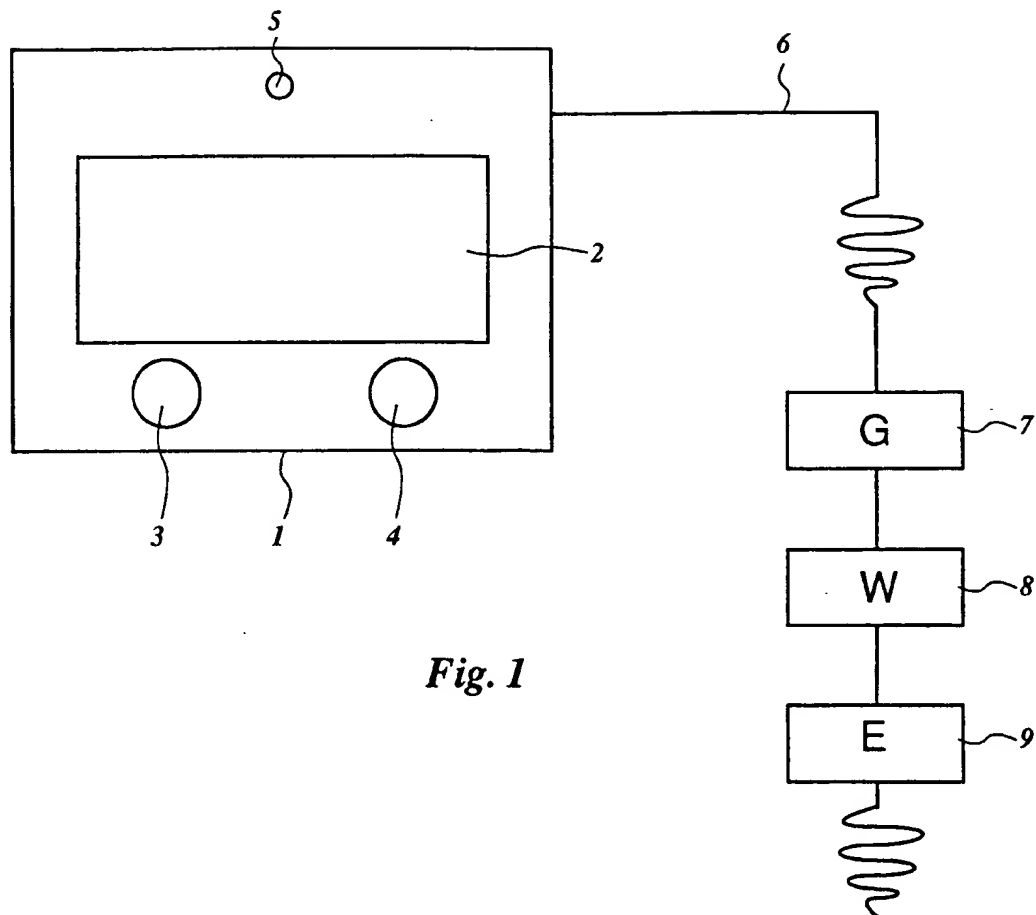
CLAIMS

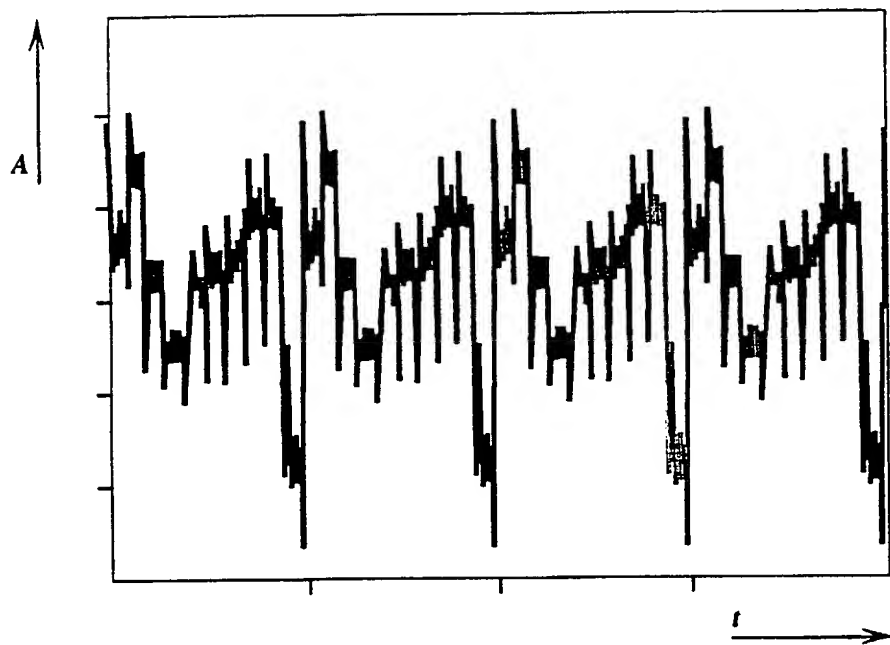
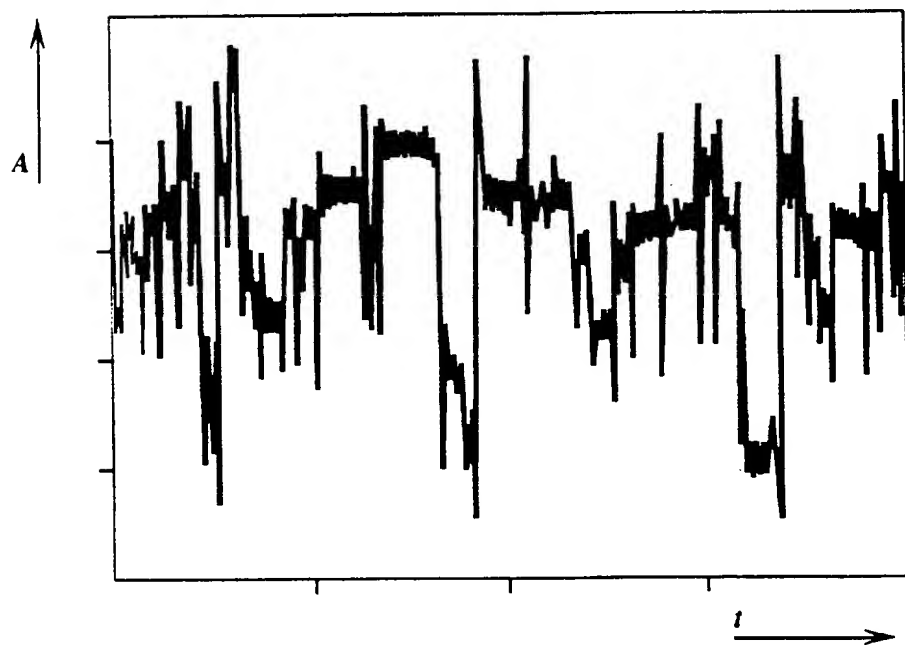
1. Device for monitoring one or more meters for supplied energy or another product or service, at least comprising:
 - one or more sensor assemblies (7, 8, 9) for monitoring
- 5 the meters;
 - a display unit (2) for displaying data; and
 - a data-processing unit,characterized in that the data-processing unit is designed to display the
- 10 information signals which are obtained using the sensor assemblies (7, 8, 9), by means of the display unit (2), as the actual consumption within a certain period of time and, at the same time, to display a target consumption in a corresponding period.
- 15 2. Device according to claim 1, characterized in that the device furthermore comprises input means (3, 4) with which the type of energy, product or service to be displayed, as well as the period of time, can be selected.
3. Device according to claim 1 or 2, characterized in
- 20 that the device comprises signalling means with which the quality of the consumption of the energy, product or service in question can be indicated.
4. Device according to claim 3, characterized in that the signalling means comprise a red and a green lamp (5).
- 25 5. Device according to one or more of claims 1 - 4, characterized in that the display unit (2) comprises a liquid crystal screen (LCD) of the dedicated display type.
6. Device according to one or more of the preceding claims, characterized in that the data-processing unit is
- 30 designed to carry out the following operations with the information signals obtained from the one or more sensor assemblies (7, 8, 9):
 - monitoring of the information signal, and
 - comparison of information already received with new
- 35 information in order to pick out a recurring sequence (19) in the information signal, which sequence corresponds to a consumption quantity.

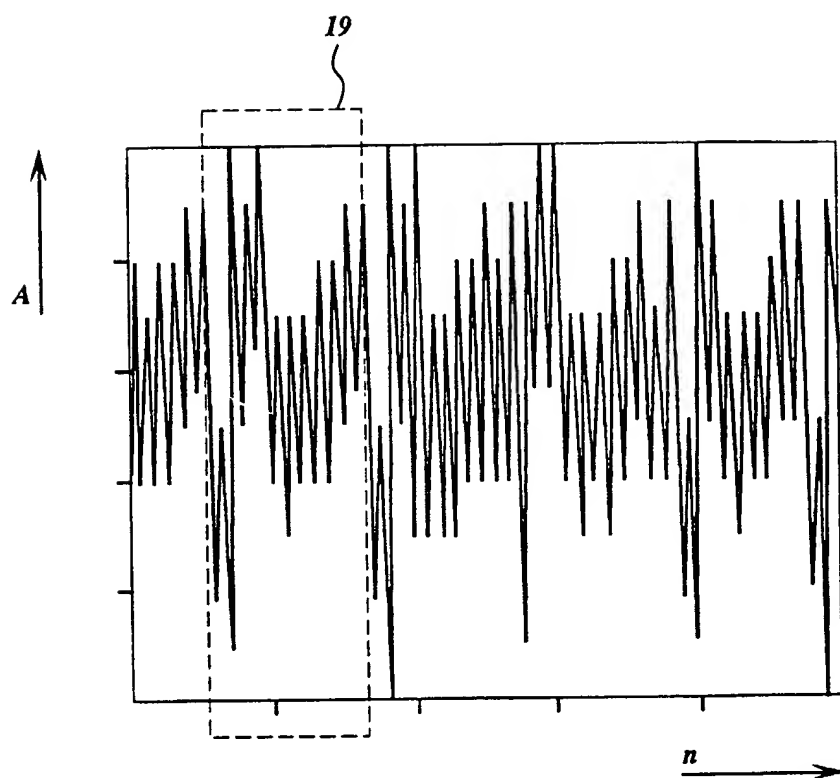
7. Device according to claim 6, characterized in that the data-processing unit is designed to make the information signal received independent of time prior to picking out a recurring sequence (19).
- 5 8. Device according to claim 7, characterized in that the data-processing unit monitors the information signal received and stores exclusively maximums and minimums, the difference between successive maximums and minimums lying above a certain noise margin, and uses these values for
- 10 picking out a recurring sequence (19).
9. Device according to one or more of claims 6 - 8, characterized in that the data processor is designed to pick out a sequence (19) which recurs in the reverse direction.
- 15 10. Device according to one or more of the preceding claims, characterized in that each sensor assembly (7, 8, 9) comprises its own sensor-signal processing unit.
11. Device according to claim 10, characterized in that each sensor-signal processing unit is designed to pick out
- 20 a recurring sequence (19) in the information signal from the sensor.
12. Device according to one or more of the preceding claims, characterized in that the one or more sensor assemblies (7, 8, 9) comprise a combination of a light
- 25 source and a light detector.
13. Sensor assembly, clearly intended for a device according to one or more of claims 1 - 12, at least comprising a sensor which can monitor a meter for supplied energy or another product or service, and a sensor signal
- 30 processing unit which is designed to be able to pick out a recurring sequence (19) in the information signal from the sensor.
14. Computer-readable medium, comprising software intended for a data-processing unit for a device according
- 35 to one or more of claims 1 - 12, or for a sensor signal processing unit for a sensor assembly according to claim 13.
15. Computer-readable medium, comprising software for configuring a computer for general purposes as a data-

processing unit for a device according to one or more of claims 1 - 12 or for a sensor-signal processing unit for a sensor assembly according to claim 13.

1/3



*Fig. 3**Fig. 4*

*Fig. 5*

INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00391

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01R22/00 G06M1/272

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 G01R G01M G06M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 581 195 A (MERLIN GERIN) 31 October 1986 see abstract see page 2, line 21 - line 30 see page 6, line 13 - line 26; figures 1-4 ---	1,3,5,14
A	CA 2 077 955 A (MALETTE) 11 March 1994 see abstract ---	1,3,12, 14
A	US 4 924 404 A (REINKE) 8 May 1990 see column 1, line 29 - line 57; figures 1,8 ---	1-3,14
A	US 5 519 622 A (CHASEK) 21 May 1996 see abstract; figure 1 see column 2, line 25 - line 67 ---	1,3,4
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

13 October 1998

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21/10/1998

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/NL 98/00391

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 717 286 A (THE GENERAL ELECTRIC COMPANY) 19 June 1996 cited in the application see column 5, line 16 - line 41 see column 6, line 34 - line 51; figures 1,3-6 ---	1,10-13
A	WO 96 21264 A (TECO) 11 July 1996 see abstract see page 4, line 16 - line 28 see page 5, line 8 - line 11 see page 5, line 25 - line 33; figures 1,2,18,29 ---	1-3,13,14
A	GB 2 019 070 A (FRESENIUS) 24 October 1979 see page 1, line 43 - line 54 ---	1
A	US 5 406 075 A (PATTENDEN) 11 April 1995 see column 4, line 7 - line 14 see column 5, line 7 - line 26; figures 3-7 -----	6,8,11

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/NL 98/00391

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2581195 A	31-10-1986	NONE	
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